Claims

What is claimed is:

[c1] A method of packaging an electronic tag, the method comprising:

heating the electronic tag so as to remove contaminants from an internal volume therein;

filling the internal volume with a potting material; and

hermetically sealing the internal volume within an outer shell.

[c2] The method of claim 1, wherein the outer shell comprises a polymer material.

[c3] The method of claim 2, wherein the polymer material comprises polytetrafluoroethylene.

[c4] The method of claim 1, wherein the outer shell comprises a ceramic material.

[c5] The method of claim 1, wherein the outer shell comprises an epoxy material.

[c6] The method of claim 5, wherein the epoxy material comprises at least one of a ceramic epoxy and a glass-filled epoxy.

[c7] The method of claim 1, wherein the potting material comprises at least one of a dielectric material, a chemically inert material, and a substantially non-outgassing material.

[c8] The method of claim 1, wherein the potting material comprises at least one of a polymer, an epoxy, a gel, and a viscous oil.

[c9] The method of claim 1, wherein the heating, filling, and sealing are performed in a substantially zero-humidity environment.

[c10] The method of claim 9, wherein the substantially zero-humidity environment comprises an argon atmosphere.

[c11] The method of claim 9, wherein the substantially zero-humidity environment comprises a nitrogen atmosphere.

[c12] The method of claim 1, wherein the internal volume is hermetically sealed while the electronic tag is under a vacuum.

[c13] The method of claim 1, further comprising positioning an adsorptive material in the internal volume.

[c14] The method of claim 13, wherein the adsorptive material is a material selected from the group consisting of alumina, activated charcoal, calcium aluminosilicate, montmorillonite clay porcelain, silica gel, a molecular sieve, and a metal silicate molecular sieve.

[c15] The method of claim 13, wherein the adsorptive material comprises a molecular sieve.

[c16] The method of claim 15, wherein the molecular sieve comprises an organosilicate or an organoaluminosilicate.

[c17] The method of claim 13, wherein the adsorptive material comprises a metal silicate molecular sieve.

[c18] The method of claim 17, wherein the metal silicate molecular sieve comprises aluminophosphate.

[c19] The method of claim 13, wherein the adsorptive material comprises a desiccant.

[c20] The method of claim 13, wherein the adsorptive material comprises sodium aluminosilicate.

[c21] The method of claim 13, wherein the adsorptive material comprises a zeolite.

[c22] The method of claim 13, wherein the adsorptive material may be selected so as to selectively adsorb a specific fluid.

[c23] The method of claim 13, wherein the adsorptive material is adapted to adsorb a corrosive gas.

[c24] The method of claim 13, wherein the adsorptive material is adapted to adsorb water vapor.

[c25] The method of claim 13, wherein the adsorptive material is effective at a temperature greater than about 200°F.

[c26] A method of packaging an electronic tag, the method comprising:
heating the electronic tag so as to remove contaminants from an internal volume therein;
filling the internal volume with a potting material;
filling any remaining volume within the internal volume with an inert gas; and
hermetically sealing the internal volume within an outer shell.

[c27] The method of claim 26, wherein the potting material comprises at least one of a dielectric material, a chemically inert material, and a substantially non-outgassing material.

[c28] The method of claim 26, wherein the potting material comprises at least one of a polymer, an epoxy, a gel, and a viscous oil.

[c29] The method of claim 26, wherein the outer shell comprises a polymer material.

[c30] The method of claim 26, wherein the outer shell comprises a ceramic material.

[c31] The method of claim 26, wherein the outer shell comprises an epoxy material.

[c32] The method of claim 26, wherein the heating, filling, and sealing are performed in a substantially zero-humidity environment.

[c33] The method of claim 26, wherein the inert gas comprises argon.

[c34] The method of claim 26, wherein the inert gas comprises nitrogen.

[c35] The method of claim 26, wherein the internal volume is hermetically sealed while the electronic tag is under a vacuum.

[c36] The method of claim 26, further comprising absorbing any remaining contaminants with an adsorptive material positioned in the internal volume.

[c37] A method of packaging an electronic tag, the method comprising:

heating the electronic tag so as to remove contaminants from an internal volume therein; and

hermetically sealing the internal volume within an outer shell.

[c38] The method of claim 37, wherein the outer shell comprises a polymer material.

[c39] The method of claim 37, wherein the outer shell comprises a ceramic material.

[c40] The method of claim 37, wherein the outer shell comprises an epoxy material.

[c41] The method of claim 37, further comprising absorbing any remaining contaminants with an adsorptive material positioned in the internal volume.

[c42] The method of claim 37, wherein the internal volume is hermetically sealed while the electronic tag is under a vacuum.

[c43] The method of claim 37, further comprising filling any remaining volume within the internal volume with an inert gas.

[c44] The method of claim 43, wherein the inert gas comprises argon.

[c45] The method of claim 43, wherein the inert gas comprises nitrogen.

[c46] A method of packaging an electronic tag, the method comprising:

applying a first coating to a circumferential antenna and an electronic tag, the first coating comprising at least one of polytetrafluoroethylene and poly-paraxylene;

applying a second coating of a polymer adapted to provide structural support to the circumferential antenna and the electronic tag.

[c47] The method of claim 46, wherein the first and second coatings comprise substantially non-outgassing materials.

[c48] The method of claim 46, wherein the applying is performed in a substantially zero-humidity environment.

[c49] The method of claim 46, wherein applying the second coating comprises dipping the circumferential antenna and the electronic tag in a polymer coating.

[c50] The method of claim 46, wherein applying the second coating comprises:

positioning the circumferential antenna and the electronic tag in a mold; and

injecting the polymer into the mold so as to form a structurally supportive layer over the chemically resistant material.

[c51] The method of claim 46, wherein applying the second coating comprises:

positioning the circumferential antenna, the electronic tag, and the polymer in a mold; and

compressing the polymer into the mold so as to form a structurally supportive layer over the chemically resistant material.

[c52] The method of claim 46, wherein a viscosity of the polymer is selected so as to control a thickness of the second coating.

[c53] The method of claim 46, further comprising hermetically sealing the circumferential antenna and the electronic tag in a polymer material.

[c54] The method of claim 53, wherein the polymer material comprises polytetrafluoroethylene.

[c55] The method of claim 46, further comprising hermetically sealing the circumferential electronic tag in a ceramic material.

[c56] The method of claim 46, further comprising hermetically sealing the circumferential electronic tag in an epoxy material.

[c57] The method of claim 56, wherein the epoxy material comprises at least one of a ceramic epoxy and a glass-filled epoxy.

[c58] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning an electronic tag in a slot formed at a selected azimuthal location in an inner wall of the tubular member;

filling the slot with a potting material so as to adhesively bond the electronic tag to the slot.

[c59] The method of claim 58, wherein the potting material comprises at least one of a dielectric material, a chemically inert material, and a substantially non-outgassing material.

[c60] The method of claim 58, wherein the potting material comprises at least one of a polymer, an epoxy, a gel, and a viscous oil.

[c61] The method of claim 58, wherein the slot comprises an undercut adapted to secure the electronic tag in place after the potting material hardens.

[c62] The method of claim 58, further comprising positioning a cover in the slot, the cover adapted to substantially cover at least a portion of the electronic tag proximate the inner wall of the tubular member.

[c63] The method of claim 62, wherein the cover comprises a flange adapted to mechanically secure the electronic tag in place after the potting material hardens.

[c64] A method of positioning an electronic tag in a tubular member, the method comprising:

radially expanding the diameter of a circumferential mounting ring coupled to the electronic tag so as to secure the electronic tag against the inner wall of the tubular.

[c65] A method of positioning electronic tags in a tubular member, the method comprising:

positioning an electronic tag in each of a plurality of slots formed at selected azimuthal and axial locations in an inner wall of the tubular member;

filling each of the plurality of slots with a potting material so as to adhesively bond each electronic tag to its corresponding slot.

[c66] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning an electronic tag in an undercut slot formed at a selected azimuthal location in an inner wall of the tubular member;

filling the undercut slot with a potting material so as to adhesively bond the electronic tag to the undercut slot, the undercut slot adapted to secure the electronic tag in place after the potting material hardens.

[c67] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning the electronic tag in a slot formed at a selected azimuthal location in an inner wall of the tubular member;

positioning a cover in the slot, the cover adapted to substantially cover at least a portion of the electronic tag proximate the inner wall of the tubular member; and

filling the slot with a potting material so as to adhesively bond the electronic tag and the cover in the slot.

[c68] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning the electronic tag in an undercut slot formed at a selected azimuthal location in an inner wall of the tubular member;

positioning a cover in the undercut slot, the cover adapted to substantially cover at least a portion of the electronic tag proximate the inner wall of the tubular member; and

filling the slot with a potting material so as to adhesively bond the electronic tag and the cover to the undercut slot, the undercut slot adapted to secure the installed electronic tag in place after the potting material hardens.

[c69] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning a threaded electronic tag in a threaded slot formed at a selected azimuthal location in an inner wall of the tubular member.

[c70] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning a threaded electronic tag in a threaded slot formed at a selected azimuthal location in an inner diameter of the tubular member;

filling a space between the threaded slot and the threaded electronic tag with a potting material, the potting material adapted to adhesively bond the threaded electronic tag to the threaded slot.

[c71] A method of positioning an electronic tag between casing joints, the method comprising:

threadedly coupling a casing collar to a first casing joint;

threadedly coupling a threaded ring to an internal diameter of the casing collar, the threaded ring comprising an electronic tag; and

threadedly coupling the casing collar to a second casing joint.

[c72] The method of claim 71, wherein the threaded ring comprises a split ring.

[c73] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning the electronic tag in a circumferential mounting ring;

positioning the circumferential mounting ring proximate an undercut slot formed in an inner wall of the tubular member; and

inserting the circumferential mounting ring into the undercut slot by deforming the circumferential mounting ring, wherein the circumferential mounting ring is adapted to return to a substantially undeformed state within the undercut slot after insertion therein.

[c74] The method of claim 73, wherein the circumferential mounting ring comprises a split ring.

[c75] The method of claim 73, wherein the circumferential mounting ring comprises ridges formed on an outer surface thereof, the ridges adapted to axially secure the circumferential mounting ring in the undercut slot.

[c76] A method of positioning an electronic tag between tubular members, the method comprising:

positioning the electronic tag in a circumferential mounting ring;

positioning the circumferential mounting ring proximate an inner surface of a collar;

positioning the collar between first and second tubular members in the wellbore.

[c77] The method of claim 76, wherein the circumferential mounting ring comprises a split ring.

[c78] The method of claim 76, wherein the circumferential mounting ring comprises ridges formed on an outer surface thereof, the ridges adapted to axially secure the circumferential mounting ring to the inner surface of the collar.

[c79] The method of claim 76, wherein the circumferential mounting ring comprises a ceramic material.

[c80] The method of claim 76, wherein the circumferential mounting ring comprises an epoxy material.

[c81] The method of claim 76, wherein the circumferential mounting ring comprises polytetrafluoroethylene.

[c82] A method of positioning a circumferential electronic tag in a tubular member, the method comprising:

positioning the circumferential electronic tag proximate an undercut slot formed in an inner wall of the tubular member; and

inserting the circumferential electronic tag into the undercut slot by deforming the circumferential electronic tag, wherein the electronic tag is adapted to return to a substantially undeformed state within the undercut slot after insertion therein.

[c83] The method of claim 82, further comprising filling the undercut slot with a potting material after positioning the electronic tag therein.

[c84] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning the electronic tag proximate a circumferential slot formed in an inner wall of the tubular member; and

radially expanding a diameter of a circumferential mounting ring coupled to the electronic tag so as to secure the electronic tag in the slot.

[c85] The method of claim 84, further comprising filling the slot with a potting material after positioning the electronic tag therein.

[c86] A method of positioning an electronic tag in a tubular member, the method comprising:

positioning the electronic tag proximate a circumferential undercut slot formed in an inner wall of the tubular member; and

radially expanding a diameter of a circumferential installation ring coupled to the electronic tag so as to secure the electronic tag in the slot.

[c87] The method of claim 86, further comprising filling the undercut slot with a potting material after positioning the electronic tag therein.

[c88] A method of positioning a circumferential electronic tag in a tubular member, the method comprising:

compressing a biased tab disposed on the circumferential electronic tag;

positioning the electronic tag in a circumferential undercut slot formed in an inner wall of the tubular member; and

releasing the biased tab so as to secure the electronic tag in the undercut slot.

[c89] The method of claim 88, further comprising filling the undercut slot with a potting material.

[c90] A method of positioning a circumferential electronic tag in a tubular member, the method comprising:

positioning the circumferential electronic tag in a circumferential slot formed in an inner wall of the tubular member, the circumferential slot comprising at least one tab formed proximate the inner wall of the tubular member; and

deforming the at least one tab so as to secure the electronic tag in the slot.

[c91] The method of claim 90, further comprising filling the slot with a potting material.

[c92] An electronic tag apparatus, comprising:

a slot formed at a selected azimuthal location in an inner wall of a tubular member;

an electronic tag disposed in the slot; and

a potting material disposed in the slot, the potting material adapted to form a barrier between the electronic tag and the inner wall of the tubular member and to adhesively bond the electronic tag to the slot.

[c93] The apparatus of claim 92, further comprising a cover adapted to be positioned in the slot and to cover at least a portion of the electronic tag.

[c94] The apparatus of claim 93, wherein the cover comprises a flange adapted to mechanically secure the cover in the slot.

[c95] An electronic tag apparatus, comprising:

a plurality of slots formed at selected azimuthal and axial locations in an inner wall of a tubular member;

an electronic tag disposed in each slot; and

a potting material disposed in the plurality of slots, the potting material adapted to form a barrier between each electronic tag and the inner wall of the tubular member and to adhesively bond each electronic tag to its corresponding slot.

[c96] An electronic tag apparatus, comprising:

a circumferential undercut slot formed in an inner wall of a tubular member;

an electronic tag disposed in the undercut slot; and

a potting material disposed in the undercut slot, the potting material adapted to form a barrier between the electronic tag and the inner wall of the tubular member and to adhesively bond the electronic tag to the slot.

[c97] The apparatus of claim 96, wherein the electronic tag comprises a flexible metal installation ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c98] The apparatus of claim 96, wherein the electronic tag comprises a flexible polytetrafluoroethylene installation ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c99] The apparatus of claim 96, wherein the electronic tag comprises a flexible epoxy installation ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c100] The apparatus of claim 96, wherein the electronic tag comprises a ratchet installation ring adapted to radially expand so as to fit within the circumferential slot.

[c101] The apparatus of claim 96, wherein the electronic tag comprises biased tabs formed thereon, the tabs adapted to compress so the electronic tag can be inserted in the slot and to release into a securing position after insertion.

[c102] An electronic tag apparatus, comprising:

a circumferential slot formed in an inner wall of a tubular member; and

an electronic tag coupled to a circumferential ring, the circumferential ring disposed in the undercut slot and adapted to secure the electronic tag in place.

[c103] The apparatus of claim 102, wherein the circumferential ring comprises a flexible metal installation ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c104] The apparatus of claim 102, wherein the circumferential ring comprises a ratchet installation ring adapted to radially expand so as to fit within the circumferential slot.

[c105] The apparatus of claim 102, wherein the circumferential ring comprises biased tabs formed thereon, the tabs adapted to compress so the circumferential ring can be inserted in the slot and to release into a securing position after insertion.

[c106] The apparatus of claim 102, wherein the circumferential ring comprises a polymer material.

[c107] The apparatus of claim 102, wherein the circumferential ring comprises a ceramic material.

[c108] The apparatus of claim 102, wherein the circumferential ring comprises an epoxy.

[c109] The apparatus of claim 102, wherein the circumferential ring comprises ridges formed on an outer surface thereof, the ridges adapted to axially secure the circumferential ring in place in the circumferential slot.

[c110] The apparatus of claim 102, wherein the circumferential ring comprises a split ring.

[c111] An electronic tag apparatus, comprising:

a first casing joint comprising threads formed on an outer surface thereof;

a second casing joint comprising threads formed on an outer surface thereof;

a casing collar comprising threads formed on an inner surface thereof, the casing collar threadedly connected to the first casing joint and the second casing joint; and

a threaded ring comprising an electronic tag and threads formed on an outer surface thereof, the threaded ring threadedly connected to the casing collar and positioned between the first and second casing joints.

[c112] The apparatus of claim 111, wherein the threaded ring comprises a split ring.

[c113] An electronic tag apparatus, comprising:

a first tubular member comprising a circumferential slot formed proximate an end thereof;

an electronic tag coupled to a circumferential ring, the circumferential ring disposed in the circumferential slot; and

a second tubular member positioned adjacent to the first tubular member proximate the slotted end so as to axially restrain the circumferential ring in the circumferential slot.

[c114] The apparatus of claim 113, wherein the circumferential ring comprises a flexible metal ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c115] The apparatus of claim 113, wherein the circumferential ring comprises a flexible polytetrafluoroethylene ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c116] The apparatus of claim 113, wherein the circumferential ring comprises a flexible epoxy ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c117] The apparatus of claim 113, wherein the circumferential ring comprises a ratchet ring adapted to radially expand so as to fit within the circumferential slot.

[c118] The apparatus of claim 113, wherein the circumferential ring comprises a polymer material.

[c119] The apparatus of claim 113, wherein the circumferential ring comprises a ceramic material.

[c120] The apparatus of claim 113, wherein the circumferential ring comprises an epoxy.

[c121] The apparatus of claim 113, wherein the circumferential ring comprises ridges formed on an outer surface thereof, the ridges adapted to axially secure the circumferential ring in place in the circumferential slot.

[c122] The apparatus of claim 113, wherein the circumferential ring comprises a split ring.

[c123] An electronic tag apparatus, comprising:

a first tubular member comprising a slot formed proximate an end thereof, the slot forming an opening in an inner surface of the tubular member;

an electronic tag disposed in the slot; and

a second tubular member positioned adjacent to the first tubular member proximate the slotted end so as to axially restrain the electronic tag in the slot.

[c124] The apparatus of claim 123, wherein the slot is filled with a potting material after the electronic tag is disposed therein.

[c125] An electronic tag apparatus, comprising:

first and second tubular members disposed in a wellbore;

a collar disposed between the first and second tubular members; and

a circumferential ring comprising an electronic tag coupled thereto, the circumferential ring disposed proximate a circumferential slot formed in an inner surface of the collar.

[c126] The apparatus of claim 125, wherein the circumferential ring comprises a flexible metal ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c127] The apparatus of claim 125, wherein the circumferential ring comprises a flexible polytetrafluoroethylene ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c128] The apparatus of claim 125, wherein the circumferential ring comprises a flexible epoxy ring adapted to deform when being inserted into the slot and to return to a substantially undeformed shape after insertion.

[c129] The apparatus of claim 125, wherein the circumferential ring comprises a ratchet ring adapted to radially expand so as to fit within the circumferential slot.

[c130] The apparatus of claim 125, wherein the circumferential ring comprises a polymer material.

[c131] The apparatus of claim 125, wherein the circumferential ring comprises a ceramic material.

[c132] The apparatus of claim 125, wherein the circumferential ring comprises an epoxy.

[c133] The apparatus of claim 125, wherein the circumferential ring comprises ridges formed on an outer surface thereof, the ridges adapted to axially secure the circumferential ring in place in the circumferential slot.

[c134] The apparatus of claim 125, wherein the circumferential ring comprises a split ring.

[c135] An electronic tag apparatus comprising:

a tubular member;

an electronic tag disposed in the tubular member; and

a signal boosting apparatus disposed in the tubular member proximate the electronic tag.

[c136] The apparatus of claim 135, wherein the signal boosting apparatus comprises a wire loop and the electronic tag is disposed inside the wire loop.

[c137] The apparatus of claim 135, wherein the signal boosting apparatus comprises a wire loop and the electronic tag is disposed outside the wire loop.

[c138] The apparatus of claim 135, wherein the signal boosting apparatus comprises a wire loop, and at least a portion of the wire loop is wound around a core.

[c139] The apparatus of claim 138, wherein the core comprises ferrite.

[c140] The apparatus of claim 138, wherein the portion the wire loop wound around the core forms a spring so that the signal boosting device may be deformed so as to install the signal boosting device in the tubular member.

[c141] The apparatus of claim 135, further comprising an installation ring, wherein the electronic tag and the signal boosting apparatus are disposed in slots formed in the installation ring, and the installation ring is adapted to be disposed in the tubular member.

[c142] The apparatus of claim 135, wherein the electronic tag is coupled to the signal boosting apparatus.

[c143] The apparatus of claim 142, wherein the electronic tag is formed as a disk and is coupled to an exterior surface of a metal ring comprising the signal boosting apparatus.